

## WHAT IS CLAIMED IS:

1. A method of determining a gap between an eddy current proximity transducer and a target, said method comprising:

providing a data structure that is populated with data that is relative to a gap value corresponding to a complex impedance value of the transducer;

exciting the transducer at a plurality of different frequencies;

determining a complex impedance value of the transducer at a respective one of the plurality of frequencies; and

determining the gap using the data structure and the complex impedance value.

2. A method in accordance with Claim 1 wherein the data structure includes a look-up table that is populated with data that is relative to at least one of the plurality of excitation frequencies, said method further comprises determining a gap value based on interpolating data in the look-up table.

3. A method in accordance with Claim 1 wherein the data structure includes a look-up table that is populated with data that is relative to each of the plurality of excitation frequencies, said method further comprises determining a gap value based on interpolating data for each respective frequency.

4. A method in accordance with Claim 3 wherein determining the gap comprises averaging the gap values.

5. A method in accordance with Claim 1 wherein exciting the transducer at a plurality of different frequencies comprises exciting the transducer at a plurality of different frequencies substantially simultaneously.

6. A method in accordance with Claim 1 wherein exciting the transducer at a plurality of different frequencies comprises exciting the transducer at three different frequencies substantially simultaneously.

7. A method in accordance with Claim 6 wherein determining a complex impedance value of the transducer comprises determining a respective complex impedance value of the transducer at each of the three frequencies substantially simultaneously.

8. A method in accordance with Claim 1 wherein determining the gap using the data structure and the complex impedance value comprises determining the gap in real-time using the data structure and the complex impedance value.

9. A method in accordance with Claim 1 wherein the data structure includes three look-up tables that each include data relative to one of the plurality of excitation frequencies, and wherein determining the gap using the data structure and the complex impedance value comprises determining a gap value at each excitation by interpolating data in each respective look-up table corresponding to each complex impedance value.

10. A method in accordance with Claim 9 wherein determining the gap comprises averaging the gap values.

11. A system for determining a gap between an eddy current proximity transducer and a target, said system comprising:

a network comprising said transducer serially coupled to an electrical component;

a signal generator circuit operatively coupled to said network, said signal generator circuit configured to drive a current that includes a plurality of frequency components through said network wherein a first analog voltage is impressed across said network and a second analog voltage is impressed across said transducer;

a sampling and digitizing circuit coupled to said signal generator circuit, said sampling and digitizing circuit configured to convert the first analog multi-frequency voltage impressed across said network and said second analog multi-

frequency voltage impressed across said transducer into a plurality of digitized voltages;

a convolution circuit comprising an input terminal corresponding to at least one of the plurality of component frequencies, said convolution circuit configured to convolve each digitized voltage with a digital waveform for forming a first complex number and a second complex number correlative to the first analog voltage and the second analog voltage respectively for at least one of the component frequencies; and

a memory comprising a data structure corresponding to at least one of the component frequencies, said data structure populated with data that is relative to gap values based on at least one of the first complex number and the second complex number.

12. A system in accordance with Claim 11 wherein said transducer includes a serially coupled cable and wherein said second analog voltage is impressed across a serial combination of said transducer and said cable.

13. A system in accordance with Claim 11 wherein said signal conditioner circuit includes a plurality of current sources, each current source configured to generate one of the plurality of frequencies of the current driver.

14. A system in accordance with Claim 13 wherein the frequency output of at least one of said plurality of current sources is at least one of selectable and programmable.

15. A system in accordance with Claim 13 wherein at least one of said current sources comprises a direct digital synthesis device.

16. A system in accordance with Claim 13 wherein said signal conditioner circuit includes three programmable direct digital synthesis devices.

17. A system in accordance with Claim 13 wherein said signal conditioner circuit includes a current source configured to generate a multi-frequency current.

18. A system in accordance with Claim 13 wherein said convolution circuit comprises a digital circuit configured to receive at least one component frequency on an input channel that is selectively tuned to the respective frequency.

19. A system in accordance with Claim 13 wherein said convolution circuit comprises a programmable digital circuit configured to receive each component frequency on a separate respective input channel that is selectively tuned to the respective frequency.

20. A system in accordance with Claim 13 wherein said convolution circuit comprises a digital down counter configured to receive at least one component frequency on a separate respective input channel that is selectively tuned to the respective frequency.

21. A system in accordance with Claim 13 wherein said memory comprises a data structure corresponding to each of the component frequencies, said data structure populated with data that is relative to gap values based on at least one of the first complex number and the second complex number.

22. A system in accordance with Claim 13 wherein said memory comprises a look-up table corresponding to each of the component frequencies, said look-up table populated with data that is relative to gap values based on at least one of the first complex number and the second complex number.

23. A system in accordance with Claim 11 further comprising a processor configured to correlate the first complex number and the second complex number for at least one of the component frequencies to respective gap data in said data structure.

24. A system in accordance with Claim 23 wherein said processor is configured to correlate the first complex number and the second complex number for

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at least one of the component frequencies to respective gap data in said data structure by interpolation.